Validity of Recreational Marathon Runners' Self-Reported Anthropometric Data

Nikolaidis, Pantelis T ; Knechtle, Beat

Abstract: While studies on large samples of recreational runners have often relied on participants' self-reported height and body mass, the validity of these data have not been investigated for this population. Hence, this study sought to examine the validity of self-reported anthropometric measures among recreational marathon runners. Female ($n = 32$) and male ($n = 135$) recreational marathon runners were requested to estimate their body mass and height (and we calculated their self-reported body mass index [BMI]), after which we took actual measures of their body mass and height and calculated their actual BMI. Participants' self-reported values underestimated their actual body mass by 0.65 kg ($p < .001$, $\eta 2 = 0.222$) and their actual BMI by 0.35 kg · m-2 ($p < .001$, $\eta 2 = 0.245$). There was a significant Assessment Method × Sex Interaction for both body mass ($p = .019$, $\eta 2 = 0.033$) and BMI ($p = .017$, $\eta 2 = 0.034$), as women underestimated body mass values more than men. Participants overestimated their height by 0.44 cm ($p < .001$, $\eta 2 = 0.075$), but the interaction of sex and assessment method for height was not statistically significant. Underestimates of body mass correlated with marathon racing speed ($r = .24$, $p = .006$) and body fat percentage ($r = -.29$, $p = .001$) in men, but not in women ($p > .05$). The disagreement between self-reported and measured anthropometric data in the present sample was lower than has been previously reported for the general population, suggesting that marathon runners may more accurately self-perceive and/or report their anthropometric characteristics. These findings are of practical value for health professionals and researchers (e.g., nutritionists and exercise physiologists) questionnaires to recreational marathon runners.

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Validity of Recreational Marathon Runners' Self-Reported Anthropometric Data

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Abstract

While studies on large samples of recreational runners have often relied on participants' self-reported height and body mass, the validity of these data have not been investigated for this population. Hence, this study sought to examine the validity of self-reported anthropometric measures among recreational marathon runners. Female (n=32) and male (n=135) recreational marathon runners were requested to estimate their body mass and height (and we calculated their 'self-reported' body mass index [BMI]), after which we took actual measures of their body mass and height and calculated their actual BMI. Participants' self-reported values underestimated their actual body mass by 0.65 kg (p<0.001, η^2=0.222) and their actual BMI by 0.35 kg.m^{-2} (p<0.001, η^2=0.245). There was a significant assessment method × sex interaction for both body mass (p=0.019, η^2=0.033) and BMI (p=0.017, η^2=0.034), as women underestimated body mass values more than men. Participants' overestimated their height by 0.44 cm (p<0.001, η^2=0.075), but the interaction of sex and assessment method for height was not statistically significant. Underestimates of body mass correlated with marathon racing speed (r=0.24, p=0.006) and body fat percentage (r=-0.29, p=0.001) in men, but not in women (p>0.05). The disagreement between self-reported and measured anthropometric data in the present sample was lower than has been previously reported for the general population, suggesting that marathon runners may more accurately self-perceive and/or report their anthropometric characteristics. These findings are of practical value for health professionals and researchers (e.g. nutritionists, exercise physiologists) questionnaires to recreational marathon runners.

Keywords: anthropometry; endurance exercise; measurement error; questionnaire

Introduction

The number of annual marathon races and participant finishers has continuously increased in recent years due to a growing number of recreational runners (Vitti, Nikolaidis, Villiger, Onywera, & Knechtle, 2019). Scientific research on recreational marathon runners has often relied on questionnaires using self-reported measures of body mass, height and even body mass index (BMI) (Boldt et al., 2018; Ponzio et al., 2018; Vickers & Vertosick, 2016). While practical, this low cost, large sample data collection method is subject to response bias (Connor Gorber, Tremblay, Moher, & Gorber, 2007), leading Seigjo et al. (2018) to identify a need to evaluate the accuracy of self-reported anthropometric data.

Most existing studies of self-reported anthropometric data were conducted on general population samples, with little data available for athlete samples (Knechtle, Rust, Rosemann, Knechtle, & Bescos, 2012), particularly recreational marathon runners. BMI has been related to both sport performance (race time) (Vickers & Vertosick, 2016) and prevalence of injuries (Vitez, Zupet, Zadnik, & Drobnic, 2017) in marathon runners who share qualities with both athletes and the general population. Despite its uncertain accuracy, self-reported data on height, body mass and BMI have been widely used in research regarding marathon runners (Boldt et al., 2018; Holmich, Christensen, Darre, Jahnsen, & Hartvig, 1989; Ponzio et al., 2018; Vadeboncoeur et al., 2012; Vickers & Vertosick, 2016; Vitez et al., 2017). Understanding the accuracy of these data is of importance to both researchers and practitioners. Moreover, considering the increased number of women and older competitors in marathon races, the relation between sex and age and anthropometric data accuracy should be examined. Consequently, the objectives of this study were to investigate differences between self-reported and measured height, body mass and BMI among recreational marathon runners, while also examining any interactions between this accuracy and participant sex and age. We hypothesized that marathon runners would over-report height and under-report body mass resulting in a lower BMI value (Nieto-García, Bush, & Keyl, 1990; Seijo et al., 2018). Moreover, we assumed that the bias in self-reporting anthropometric characteristics in recreational marathon runners would be smaller than that observed among the general population, considering the specific physiological and psychological characteristics of athletes (Knechtle et al., 2012). For the purpose of this study, 'self-reported BMI' referred to BMI calculated from self-reported height and body mass.

Method

Participants

Participants were 32 female (*M* age = 44.3, *SD* = 8.7 years; *M* height = 176.2, *SD* = 5.9 cm; *M* body mass = 57.7, *SD* = 7.5 kg; and *M* BMI = 21.8, *SD* =2.2 kg.m^{-2}) and 135 male (*M* age =40.1, *SD* =9.0 years; *M* =height 162.3, *SD* = 6.5 cm; *M* body mass = 76.9, *SD* = 9.3 kg; and *M* =BMI = 24.8, *SD* = 2.6 kg.m^{-2}) recreational marathon runners. Participants were invited through local media and sport clubs in the Attica region of Greece. The only inclusion criterion was participating and finishing the 2017 Athens marathon. After having been informed about the research procedures, all participants provided written informed consent. The study design was approved by the Exercise Physiology Laboratory, Nikaia, Greece (EPL 2017/7) in accordance with the Declaration of Helsinki revised in 2013.

Procedures

The present study was part of a larger project on physiological characteristics of recreational marathon runners for which detailed procedures were published in Nikolaidis, Chalabaev, Rosemann and Knechtle (2019) and Nikolaidis, Rosemann and Knechtle (2018a; 2018b). Briefly, in the context of the participants' visit to an exercise physiology laboratory to perform a series of anthropometric and exercise tests, participants were administered a questionnaire including items about their height and body mass. It should be highlighted that participants were aware when completing the questionnaire that they would later have their, height and body mass measured. Based on their self-reported height and body mass index, we calculated their 'self-reported' BMI. Height and body mass were then actually measured with participants barefoot and wearing minimal clothing. We used a weighing scale (Tanita, Arlington Heights, IL, USA) to measure body mass to the nearest 0.1 kg, and a portable stadiometer (SECA Leicester, UK) to measure height to the nearest 0.1 cm. BMI was calculated as the quotient of body mass (kg) to height squared (m^2). A comparison of normal-weight *versus* over-weight BMI groups was performed for male participants since there were too few over-weight female participants (n = 1) to permit this comparison.

Statistical and data analysis

Statistical analyses were conducted using GraphPad Prism v. 7.0 (GraphPad Software, San Diego, USA) and IBM SPSS v.23.0 (SPSS, Chicago, USA). We set statistical significance at p=0.05. We tested the data distribution for normality using the Kolmogorov-Smirnov test and visual inspecting Q-Q plots. Data are presented as means and standard deviations. We used a between-within analysis of variance (ANOVA) to examine the main and interaction effects of assessment method (self-reported and measured) and sex on height, body mass and BMI, and we used eta squared (η^2) to estimate the magnitude of these differences (Cohen, 1988). We used Bland-Altman plots to analyze the agreement between self-reported and measured values (Bland & Altman, 1986), and we used Pearson correlation coefficient r to examine the relationship between the difference value of the reported minus the measured and the average of the reported and measured value ((reported+measured)/2) for each anthropometric measure. In addition, we used r to examine the relationship between the self-report bias in anthropometric measures and age. We used an independent Student *t*-test to compare the self-reported and measured height, body mass and BMI between normal-weight and over-weight male participants, and we used Cohen's d to evaluate the magnitude of differences (Cohen, 1988).

Results

Participants' self-reported body mass significantly underestimated both their actual body mass by an average of 0.65kg (t_{166}=6.762, p<0.001, d=0.06) and their actual BMI by an average of 0.35 kg.m^{-2} (t_{166}=7.288, p<0.001, d=0.13) (see Figure 1). An ANOVA also revealed a significant assessment method × sex interaction for both body mass ($F_{1,165}$=5.576, p=0.019, η^2=0.033) and BMI ($F_{1,165}$=5.862, p=0.017, η^2=0.034), with women underestimating body mass and BMI more than men. Participants' self-reported height significantly overestimated actual height by an average of 0.44 cm (t_{166}=4.087, p<0.001, d=0.05). There was no significant assessment method × sex interaction for height.

[Insert Figure 1 about here.]

The participant self-report bias (i.e., difference between participants' reported and measured values) can be seen in Figure 2. There were statistically non-significant correlations between this bias or difference between reported and measured values and the average of these values ((reported+measured)/2) for height (females, r=-0.04; males, r=-0.13), body mass (females, r=-0.15; males, r=-0.14) and for females' BMI (r=-0.17) while there was a small but significant negative correlation between these variables for males' BMI (r=-0.20, p=0.019), indicating that males with higher measured BMI under-reported their BMI more than did males with lower measured BMI.

[Insert Figure 2 about here.]

Age was not significantly correlated with female participants' reporting bias for height (r=0.11), body mass (r=-0.28) or BMI calculations (r=-0.34), but male participants' age was significantly correlated with their reporting bias for height (r=0.20, p=0.023) and BMI calculations (r=-0.17, p=0.049), but not for body mass (r=-0.04). Older male participants over-reported height and under-reported BMI more than their younger counterparts. Table 1 depicted the response bias comparisons between normal-weight and overweight male participants. There were no significant differences between normal and over-weight male participants with respect to age, measured and self-reported height, and Δheight. Compared to their normal-weight peers, over-weight participants had larger measured (t_{133}=-9.283, p<0.001, d=1.58) and self-reported body mass (t_{133}=-8.602, p<0.001, d=1.46), and greater Δbody mass (t_{133}=-3.678, p<0.001, d=0.62), as well as larger measured BMI (t_{133}=-14.016, p<0.001, d=2.35) and self-reported BMI (t_{133}=-12.522, p<0.001, d=2.08), and greater ΔBMI (t_{133}=3.700, p<0.001, d=0.63).

[Insert Table 1 about here.]

Discussion

Main findings of the present study were that (a) recreational marathoners under-reported their body mass (i.e., they claimed that they were lighter than measurements revealed) leading to underestimated BMIs, and they over-reported their height (i.e., they claimed that they were taller than measurements revealed); (b) female marathon runners under-reported their body mass (and therefore our calculations of their BMI) more than did males; (c) male marathon runners with higher measured BMI under-reported their body mass (and therefore our calculations of their BMI) more than their counterparts with lower measured body mass; and (d) older male marathon runners over-reported their height and under-reported their body mass (and therefore our calculations of their BMI) more did than their younger counterparts.

The observed self-report bias in these anthropometric characteristics was consistent with reports from previous research with different participant samples, confirming a general human tendency to overestimate height and underestimate body mass, frequently resulting in calculations that underestimate BMI (Basterra-Gortari, Bes-Rastrollo, Forga, Martínez, & Martínez-González, 2007; Bes-Rastrollo, Pérez Valdivieso, Sánchez-Villegas, Alonso, & Martínez-González, 2005; Bibiloni et al., 2016). The marathon runners' self-report bias for body mass (~0.6kg), BMI (~0.35 kg.m^{-2}) and height (~0.4cm) observed in the present study was consistent with a previous study of athletes that reported an underestimate of BMI calculations by 0.4 kg.m^{-2} (Knechtle et al., 2012). On the other hand, our marathon runners' self-report bias was smaller than has been reported in the general population (Ikeda, 2016). In addition, since BMI was related to marathon race time (Vickers & Vertosick, 2016) and runners' injury prevalence (Vitez et al., 2017), marathon runners may more frequently monitor their body mass.

An analysis of sex×assessment method interactions on these anthropometric characteristics revealed that female marathon runners under-reported their body mass more than their male counterparts, also leading to females' under-reported BMI in our BMI calculations based on their self-reported body mass. Our findings were also consistent with the results of previous studies on different participant samples (Alvarez-Torices, Franch-Nadal, Alvarez-Guisasola, Hernandez-Mejia, & Cueto-Espinar, 1993; Bolton-Smith, Woodward, Tunstall-Pedoe, & Morrison, 2000; Roberts, 1995; Stunkard & Albaum, 1981). Under-reporting of body mass among female participants in these studies has been attributed to women's particularly prevalent desire to be slim (Bolton-Smith et al., 2000; Giles & Hutchinson, 1991; Nichter & Nichter, 1991). However, further investigation of the cause or reason for this differential sex finding is needed. We also observed a self-report based BMI bias among those male runners with higher self-report based BMI levels, although these BMI calculation differences may have been largely influenced by differences in the participants' self-reported height, rather than in self-reported body mass. This finding was based both on the Bland-Altman plots analysis and the comparison between normal-weight and over-weight male runners. The higher under-estimation of BMI using self-report measures in participants with high BMI, compared to their counterparts with lower BMI, highlighted the need to interpret such data with caution (Alvarez-Torices et al., 1993; Nieto-García et al., 1990).

With regards to the role of age in self-report bias, we found a larger bias among older versus younger male marathon runners, consistent with prior findings in studies of athletes (Knechtle et al., 2012) and non-athletes (Kuczmarski, Kuczmarski, & Najjar, 2001). Knechtle et al. (2012) showed that male (but not female) athletes >35 years old under-reported body mass (and our calculations of their BMI) more than their younger counterparts. Kuczmarski et al. (2001) found that self-report bias in BMI calculations among non-athletes increased directly with age. Under-reporting BMI in older adults might be attributed partly to over-reporting height, due to the lengthy time passage since height was last measured and/or reduction that occurs in height with age (Stewart, Jackson, Ford, & Beaglehole, 1987). However, it is also clearly possible that this self-report bias emanates from a particularly prevalent male desire to be taller. As with speculations regarding women's particular self-report bias toward under-estimating body mass, this possibility warrants further research.

Limitations of the present study include the lack of additional data to investigate or delineate underlying reasons for sex-specific, age-specific, or BMI level-specific findings regarding self-report bias. Additionally, our participants recorded their self-reported data using a 'paper and pencil' questionnaire, introducing a methodological difference relative to studies that used interviews or online tools to collect these data. Furthermore, the self-report bias we observed may be contextually limited to the Greek culture (Ng, 2019). The findings of our study should be considered with caution given our sample size and should be verified in future studies using larger samples. We acknowledge that our sample size (n=167) was smaller than that of studies participants in the general population (e.g. n=272, Arjunan et al., 2019). Additionally, our participants were aware that they were going to be measured for actual height and body mass subsequent to completing questionnaires on which they self-reported these variables; this knowledge may have influenced the degree of bias they expressed, perhaps helping to explain a smaller bias in this sample than in studies with participants in the general population. A strength of our study was its novel use of a sample of recreational marathon runners who may be seen as falling between athletes and non-athletes. Given the wide use of self-report measures to collect anthropometric data on marathon runners (Ponzio et al., 2018; Vitez et al., 2017), our findings should be useful to researchers and practitioners attempting to interpret data from these self-report assessment methods.

Conclusions

Marathon runners under-reported body mass and calculated BMI, and over-reported height, though the degree of disagreement between self-reported and measured anthropometric data in the present sample was lower than has been observed in other studies, perhaps suggesting that marathon runners may have a more accurate self-perception or may more accurately report their anthropometric characteristics compared to members of the general population. According to our findings, self-reported body mass and height is apt to be inaccurately reported by marathon runners, perhaps particularly for women with regard to under reports of body mass and for older men with regard to over reports of height. The present study was the first to examine the validity of such measures in recreational marathon runners.

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Table 1. Self-reported and measured anthropometric characteristics.

	Normal-weight (n=82)	Overweight (n=53)
Age (years)	43.2±8.3	46.0±9.2
Height		
Measured height (cm)	176.6±5.9	175.6±5.9
Self-reported height (cm)	176.9±5.6	176.3±5.9
Δheight (cm)	0.2±1.3	0.6±1.5
Weight		
Measured weight (kg)	72.2±6.3	84.2±8.6*
Self-reported weight (kg)	72.0±6.2	83.2±8.9*
Δweight (kg)	-0.2±1.0	-1.0±1.4*
BMI		
Measured BMI ($kg.m^{-2}$)	23.1±1.3	27.3±2.1*
Self-reported BMI ($kg.m^{-2}$)	23.0±1.3	26.7±2.2*
ΔBMI ($kg.m^{-2}$)	-0.1±0.5	-0.5±0.7*

*$p<0.001$. Δ=difference; BMI=body mass index.

Legends of figures

Figure 1. Variation of height, body mass and body mass index by assessment method and sex.

BMI=body mass index. * main effect of assessment method on variable at $p<0.05$. # sex×assessment method interaction on variable at $p<0.05$.

Figure 2. Bland-Altman plots showing the difference (bias) between reported and measured height, weight and body mass index.

BMI=body mass index; Difference=reported-measured; Average=(reported+measured)/2.

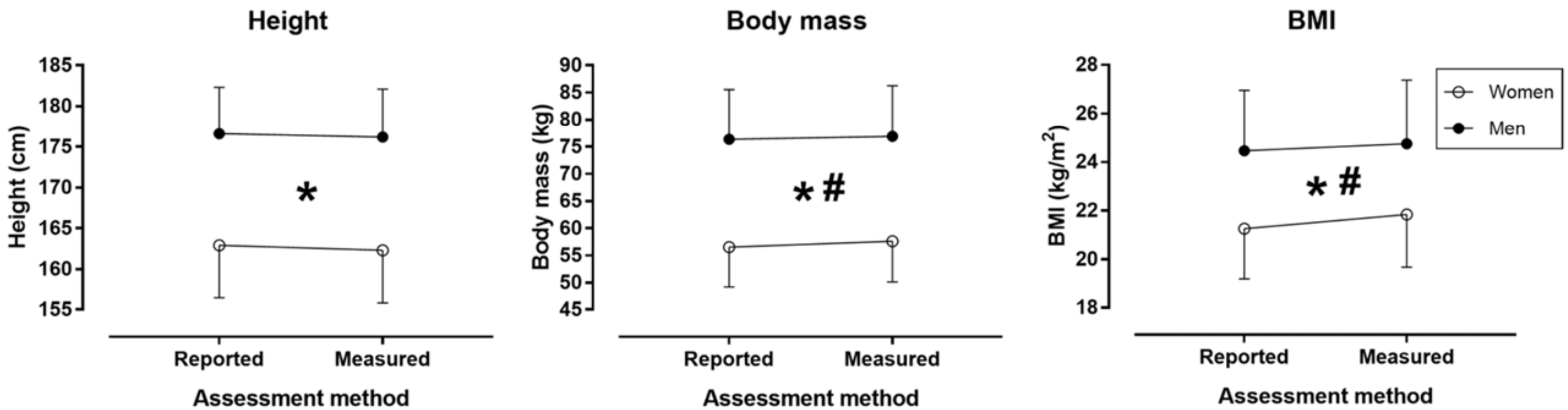
Height
Height (cm)
185
180
175
170
165
160
155
*
Reported
Measured
Assessment method
Body mass
Body mass (kg)
90
85
80
75
70
65
60
55
50
45
* #
Reported
Measured
Assessment method
BMI
BMI (kg/m^2)
28
26
24
22
20
18
* #
Women
Men
Reported
Measured
Assessment method

Figure 1

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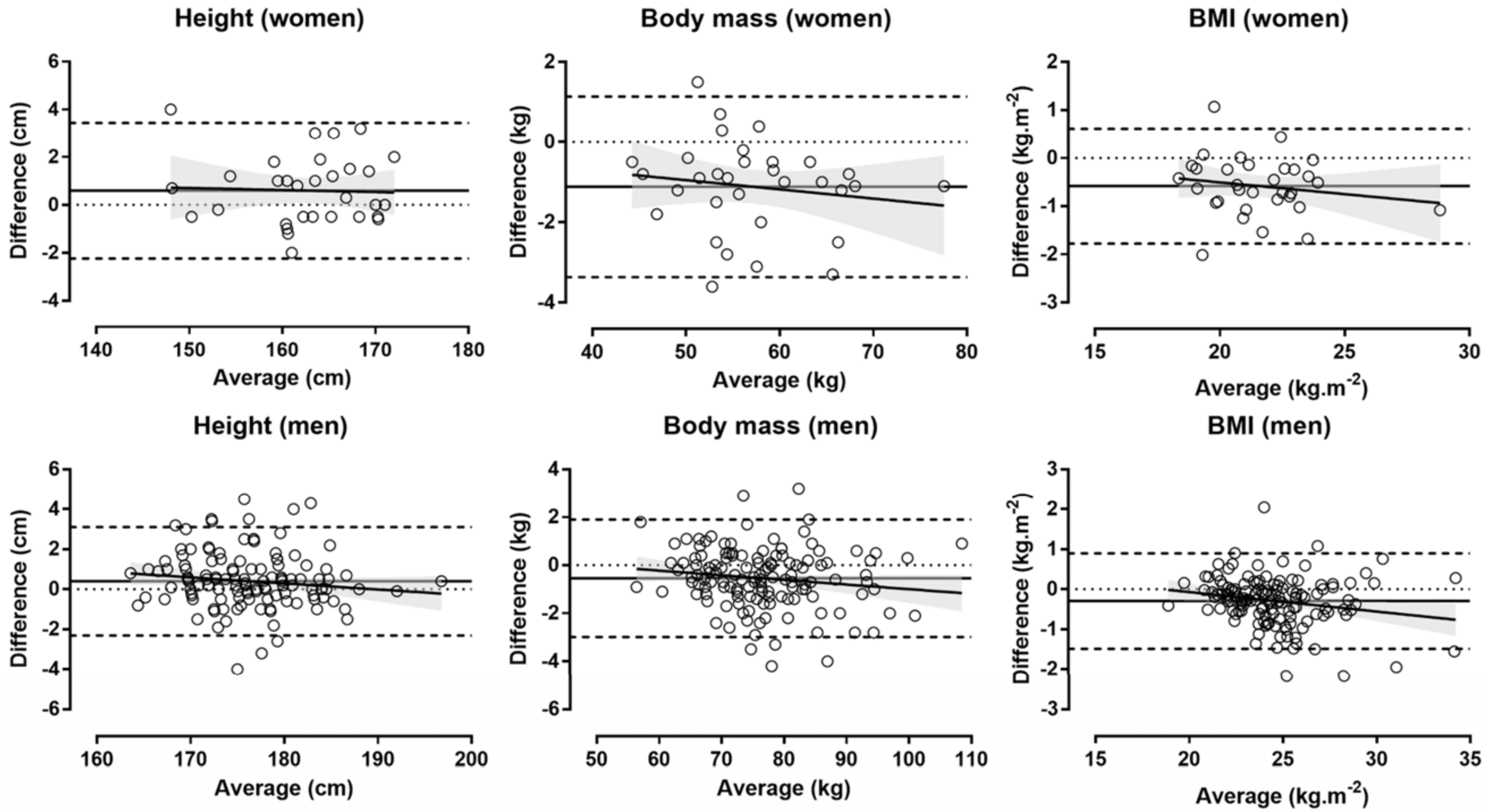

397 **Figure 2**